Appendix C

Shoreline Monitoring Report

SANTA MONICA BAY SHORELINE MONITORING ASSESSMENT REPORT
(July 1, 2001- June 30, 2002)

Monitoring and Assessment by the City of Los Angeles

I. INTRODUCTION

Santa Monica Bay is economically important due to coastal tourism and recreational uses, such as swimming, surfing, diving, sports fishing, and boating. Ensuring that Santa Monica Bay is safe for recreational use is an important public health concern. For this reason, shoreline monitoring stations are now closer to storm drains. These efforts have the support and participation of regulatory agencies, wastewater dischargers, and environmental groups.

Epidemiological studies have established that exposure to polluted bodies of water during recreational use is associated with disease (Cabelli et al. 1982; Dadswell 1993; Van Asperen et al. 1995; SMBRP 1996). This City of Los Angeles report assesses the shoreline monitoring requirements under the Municipal Stormwater National Pollutant Discharge Elimination System (NPDES) Permit Number CAS004001. The City of Los Angeles has conducted bacteriological monitoring of Santa Monica Bay's shoreline waters on a regular basis since the mid-1950's to assess water quality in areas used for water-contact recreation and where shellfish may be harvested for human consumption. Extensive past monitoring has shown that the Hyperion wastewater plume does not reach the shoreline or inshore waters of Santa Monica Bay (CLA, EMD 1999).

Urban runoff is the largest non-point source of pollution to the shoreline of Santa Monica Bay. Urban runoff has two major origins: rainfall and street runoff. Street runoff can result from domestic activities, irrigation water, and commercial or industrial activities. Runoff reaches Santa Monica Bay through numerous storm drains that empty directly into the Bay or flow onto the beach and then into the Bay. It has been estimated that Santa Monica Bay receives a flow of 10-25 million gallons per day from storm drains during dry weather (SMBRP 1996).

Santa Monica Bay shoreline stations and major storm drains are sampled on a routine basis throughout the year to monitor the influence of urban runoff on the bacteriological water quality of Santa Monica Bay. Bacteriological data collected from July 1, 2001 through June 30, 2002 at these sampling locations are summarized herein.

Bacterial counts for the indicator organisms total coliform, fecal coliform, and *Enterococcus* are transmitted electronically to the Los Angeles County Department of Health Services (LACDHS). This daily communication helps protect public health by allowing LACDHS to make a prompt response when it is necessary to close a public beach where bacterial water quality standards have been exceeded. Bacterial counts are also submitted on a weekly basis to Heal the Bay for use in producing their weekly Beach

Report Card.

II. MATERIALS AND METHODS

A. SAMPLING LOCATIONS

Water samples from 18 Santa Monica Bay shoreline locations were collected daily. Shoreline locations ranged southward from Surfrider Beach in Malibu to Malaga Cove in Palos Verdes (Figure 1). All shoreline stations are sampled 50 yards away from where the storm drain flow meets the shoreline. All samples were collected 0.1 meters below the water's surface during daylight hours.

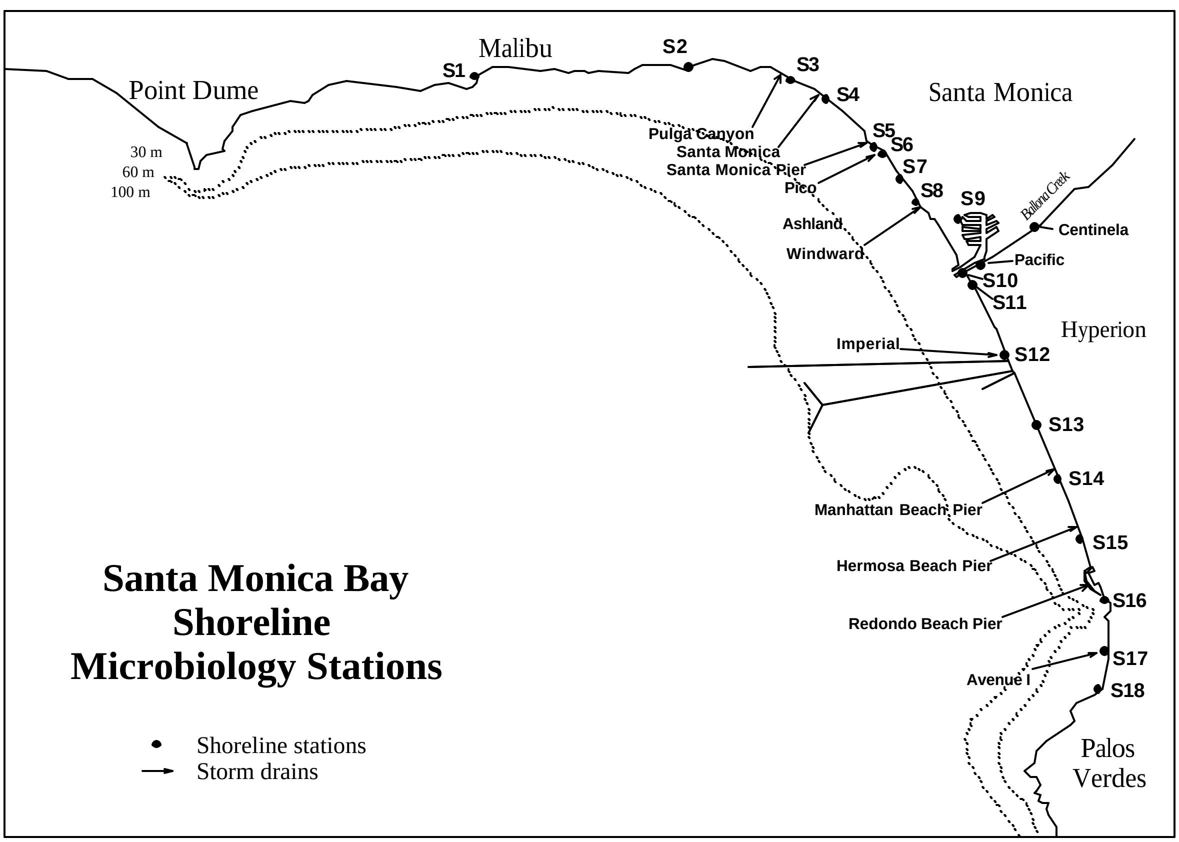


Figure 1. Shoreline monitoring stations in Santa Monica Bay.

B. METHODOLOGY

Water samples were collected and analyzed according to Standard Methods (APHA 1992). Total coliform, fecal coliform, and enterococcus bacterial densities were determined by the membrane filtration method as recommended in sections 9222B, 9222D, and 9230C, respectively.

Shoreline samples were tested daily for total and fecal coliforms and five times a month for enterococcus bacteria.

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1992). These areas included sampling techniques, sample storage and holding, facilities, personnel, equipment, supplies, media, and analytical test procedures. In addition, duplicate analyses were performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was initiated. This quality assurance program helped ensure the production of uniformly high quality and defensible data. All shoreline samples and subsequent analyses were performed by the City of Los Angeles, Bureau of Sanitation, Environmental Monitoring Division (EMD), Microbiology Unit is certified by the California State Department of Health Services (CSDHS) Environmental Laboratory Accreditation Program to conduct the microbiological testing used in this study.

C. DATA ANALYSIS

1. Geometric mean

In many cases, the results obtained from microbiological samples will not be normally distributed. To compensate for a skewed distribution and to obtain a nearly normal distribution, data must be log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group. Annual geometric means were calculated for all shoreline data.

Shoreline data were divided into periods of wet and dry weather to examine the effects of storm drain runoff on indicator bacterial concentrations. Regulatory agencies have defined wet weather as the day of rain plus the following three days.

III. RESULTS

A. SANTA MONICA BAY SHORELINE STATIONS

1. Rainfall

Wet weather is defined as those days with 0.1 inch of rain or more and the three days following the rain event. There was a total of 42 days that met this criteria during 2001-2002.

There were eight months with rainfall during 2001-2002, with November 2001 receiving the most rain – approximately one third of the total rainfall for the period (Figure 2). Daily rainfall amounts are shown in Figure 3.

2. Shoreline Stations

Generally, the annual geometric means for all indicator bacteria during wet weather were higher than those during dry weather (Figure 4, Table 1), especially near large storm drains (Figure 1). Stations S4, S5, and S16 (Redondo Pier) were highest in all three indicators during dry weather. During wet weather Station S1 (Malibu Creek), S6 (Pico-Kenter storm drain), and S10 (Ballona Creek) were highest in total coliforms. Stations S1, S5, and S9 were highest in fecal coliforms, whereas stations S1, S9, and S10 were highest in enterococcus bacteria.

The highest bacterial densities corresponded well with rain events, especially November 2001 through February 2002 (Figure 5).

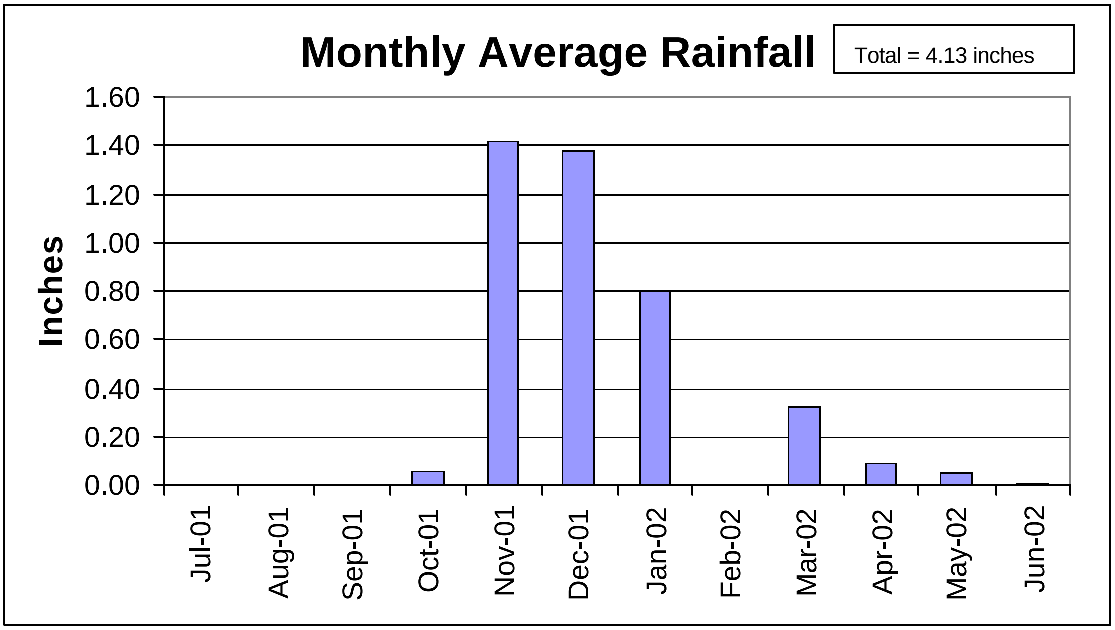


Figure 2. Monthly average rainfall data for Los Angeles region.

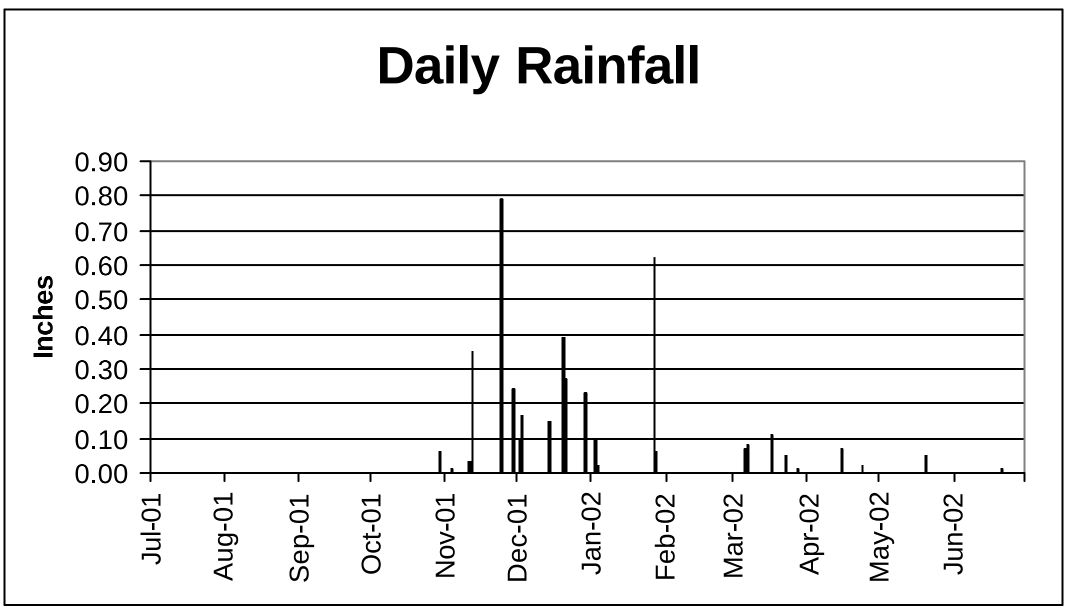


Figure 3. Daily Rainfall for Los Angeles region.

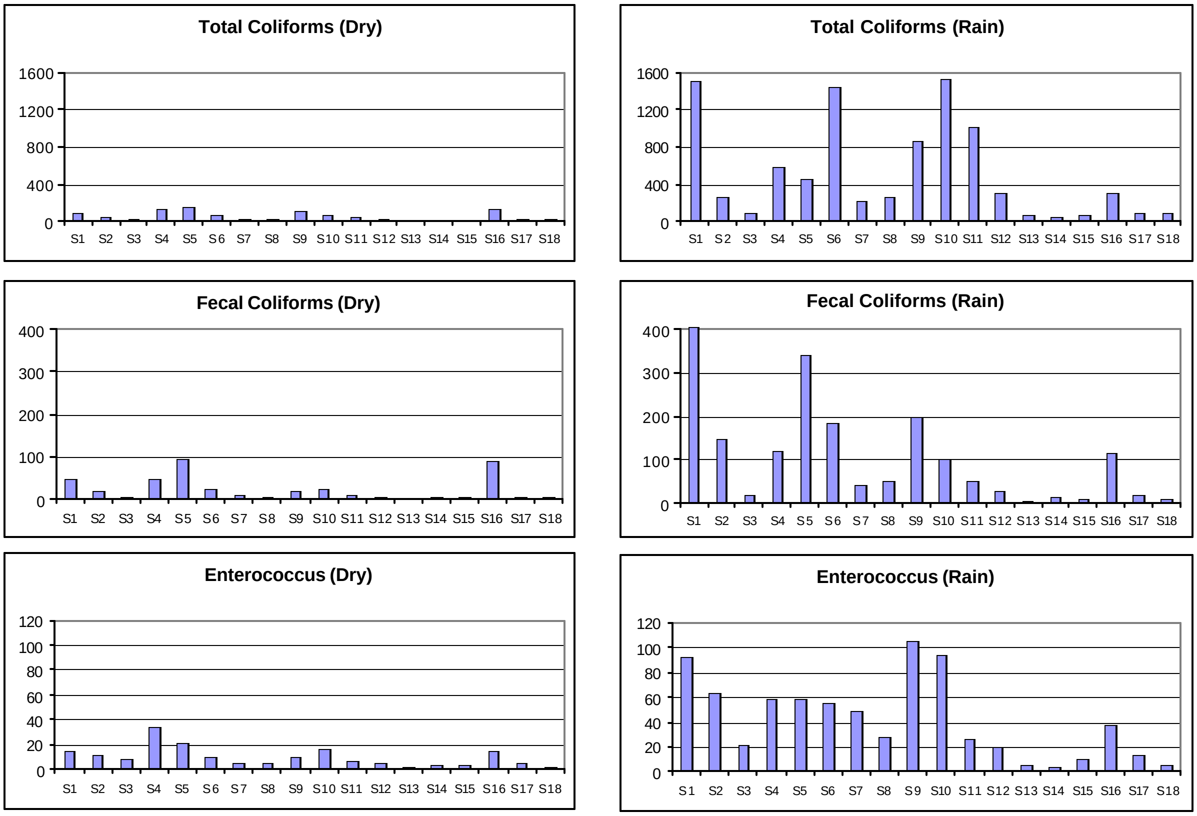


Figure 4. Annual geometric means for indicator bacteria at shoreline stations in Santa Monica Bay, 2001-2002 by station, separately for dry and wet weather. Units are in colony forming units (CFU)/100mL.

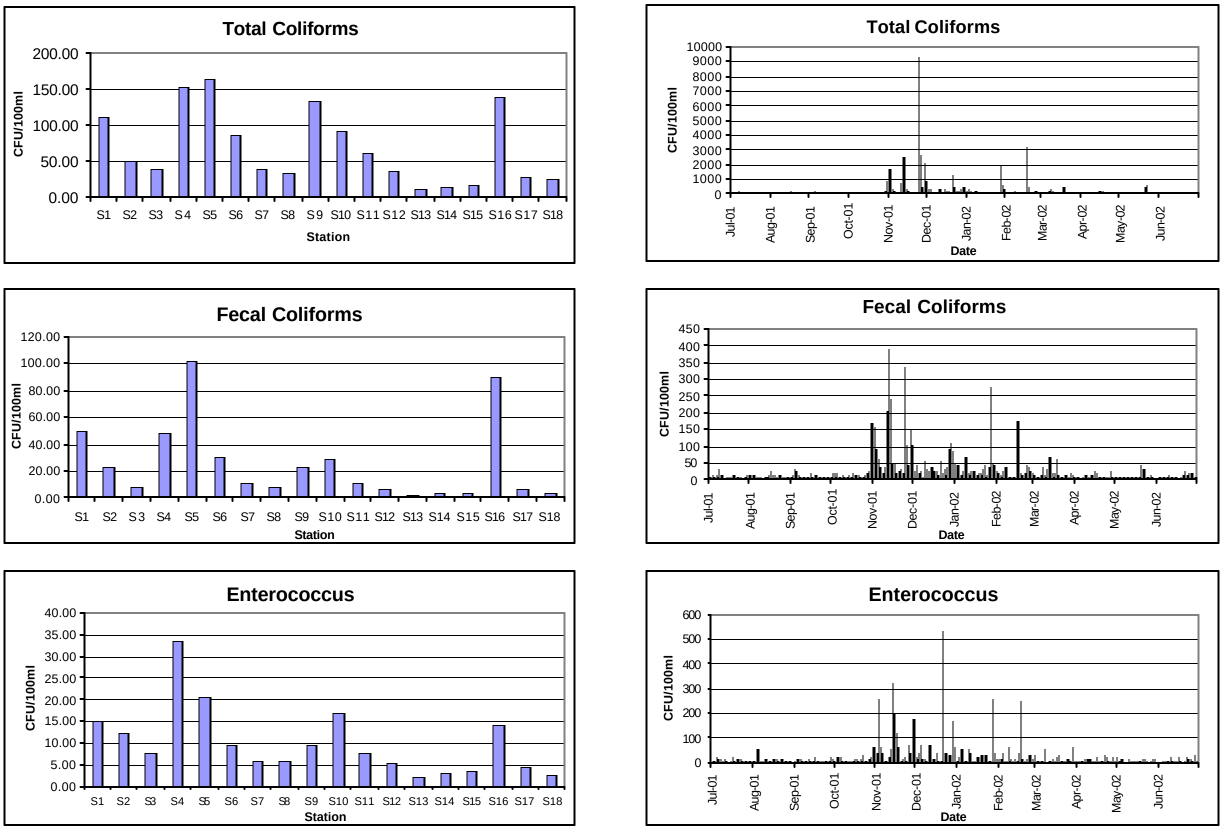


Figure 5. Annual geometric means for indicator bacteria at shoreline stations in Santa Monica Bay, 2001-2002 by station and date for wet and dry weather, combined. Units are in colony forming units (CFU)/100mL.

Table 1. Summary of simple statistics for the Santa Monica Bay shoreline stations for the period between July 1, 2001 and June 30, 2002. TOT = total coliform, FEC = fecal coliforms, and ENT = enterococcus. All units are in CFU/100 mL.

DATE	S1			S2			S3		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	1,259	204	50	201	77	38	179	25	28
Maximum	92,000	5,300	380	10,000	1,300	570	6,400	370	350
Minimum	4	1	1	4	1	1	4	1	1
Range	91,996	5,299	379	9,996	1,299	569	6,396	369	349
GeoMean	81	37	14	42	21	12	38	8	8
StDev	6,052	429	80	725	164	90	670	51	60
DATE	S4			S5			S6		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	811	104	82	698	217	123	1,239	129	53
Maximum	92,000	1,600	730	49,000	5,500	4,100	84,000	15,000	550
Minimum	4	1	2	4	1	2	4	1	1
Range	91,996	1,599	728	48,996	5,499	4,098	83,996	14,999	549
GeoMean	148	47	35	156	98	20	74	27	9
StDev	5,374	165	145	3,395	377	543	6,156	821	115
DATE	S7			S8			S9		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	769	39	38	413	35	18	975	127	100
Maximum	48,000	3,300	1,600	73,000	4,300	370	120,000	4,600	4,200
Minimum	4	1	1	4	1	1	4	1	1
Range	47,996	3,299	1,599	72,996	4,299	369	119,996	4,599	4,199
GeoMean	33	9	5	31	8	5	108	18	8
StDev	4,518	186	207	4,171	235	50	7,452	405	541
DATE	S10			S11			S12		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	1,116	76	1,351	902	38	22	577	31	17
Maximum	64,000	2,000	120,000	63,000	1,200	270	17,000	1,600	330
Minimum	4	1	1	4	1	1	4	1	1
Range	63,996	1,999	-1	62,996	1,199	269	16,996	1,599	329
GeoMean	79	26	16	55	10	7	32	6	5
StDev	5,038	187	6,663	4,853	113	43	2,316	108	46
DATE	S13			S14			S15		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	148	11	6	93	17	18	195	15	17
Maximum	11,000	770	54	5,600	430	290	15,000	280	280
Minimum	4	1	1	4	1	1	4	1	1
Range	10,996	769	53	5,596	429	289	14,996	279	279
GeoMean	10	2	2	11	3	3	13	3	3
StDev	825	50	10	416	47	49	1,133	38	49
DATE	S16			S17			S18		
	TOT	FEC	ENT	TOT	FEC	ENT	TOT	FEC	ENT
Average	581	173	32	501	38	110	191	9	5
Maximum	25,000	1,100	280	40,000	3,700	4,300	26,000	240	26
Minimum	4	1	1	4	1	1	4	1	1
Range	24,996	1,099	279	39,996	3,699	4,299	25,996	239	25
GeoMean	122	82	13	24	5	4	22	4	2
StDev	2,101	205	50	2,824	215	626	1,577	19	7

3. Water Quality Standards

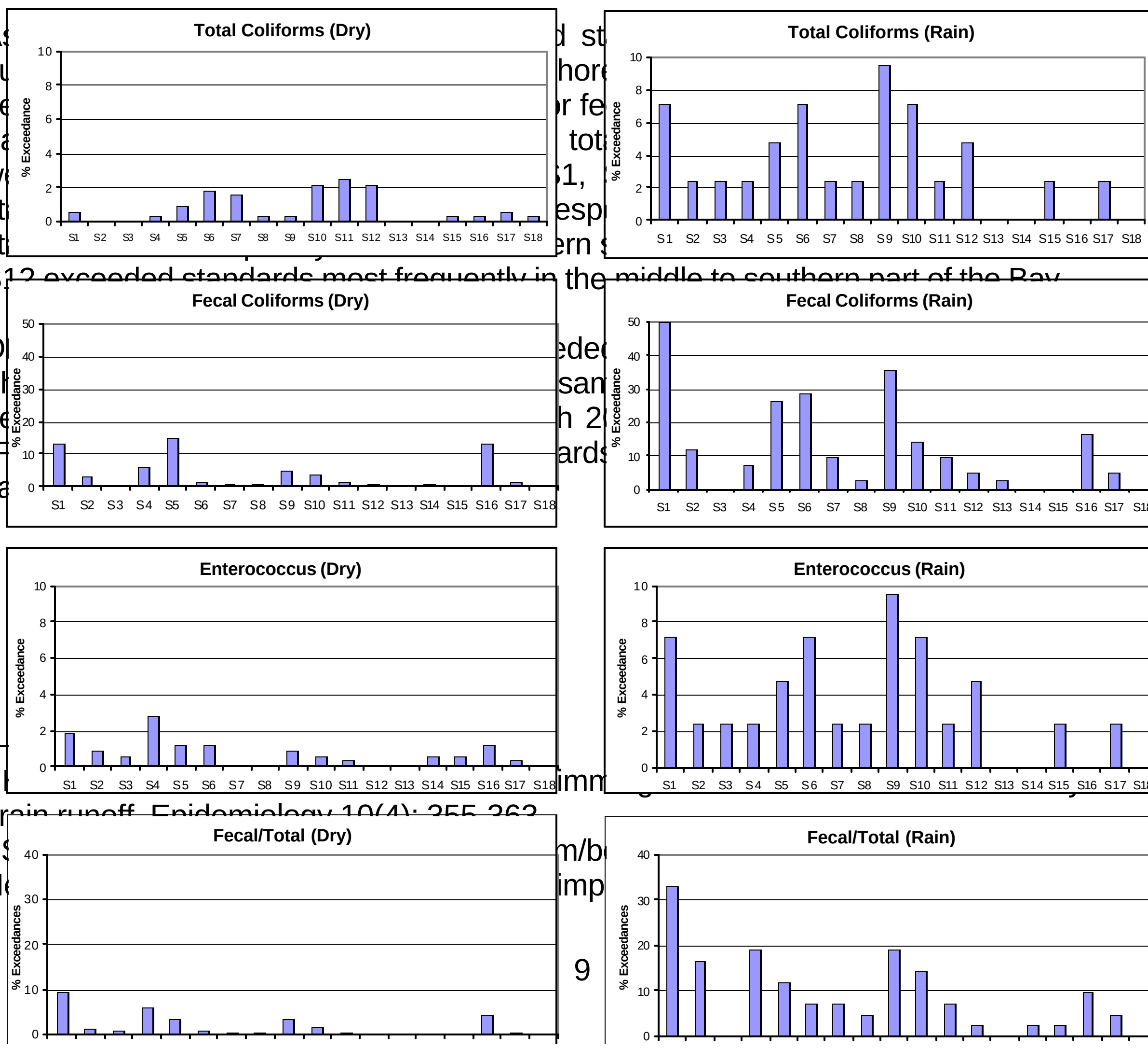
Urban runoff that reaches the shoreline is potentially contaminated with microorganisms that could make swimmers ill as demonstrated by a health-effects study conducted along several beaches in the Bay[1]. Further, levels of indicator bacteria measured during routine shoreline monitoring around drains in the Bay often exceed bathing water standards established through State legislation AB411 for public salt water beaches[2].

The AB411 water-contact standards for recreational waters are listed in Table 2.

Table 2. AB411 bathing standards.

AB411 bathing standards require that a single sample shall not exceed:

- 10,000 total coliform bacteria/100mL or
- 400 fecal coliform bacteria/100mL or
- 104 Enterococcus bacteria/100mL or
- 1,000 total coliform bacteria/100mL, if the ratio of fecal/total bacteria exceeds 0.1.



S12 exceeded standards most frequently in the middle to southern part of the Bay.

drain runoff. Epidemiology 10(4): 355-363.

Table 3. Percent of Santa Monica Bay shoreline samples that exceeded bathing standards during both wet and dry weather July 1, 2001 – June 30, 2002.

Percent Exceedance

	Total Coliforms		Fecal Coliforms		Enterococcus		Fecal/Total Ratio	
Station	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
S1	0.6	7.1	13.4	50.0	1.9	7.1	9.3	33.3
S2	0.0	2.4	3.4	11.9	0.9	2.4	1.2	16.7
S3	0.0	2.4	0.3	0.0	0.6	2.4	0.6	0.0
S4	0.3	2.4	6.2	7.1	2.8	2.4	5.9	19.0
S5	0.9	4.8	15.2	26.2	1.2	4.8	3.4	11.9
S6	1.9	7.1	1.6	28.6	1.2	7.1	0.9	7.1
S7	1.6	2.4	0.9	9.5	0.0	2.4	0.3	7.1
S8	0.3	2.4	0.9	2.4	0.0	2.4	0.3	4.8
S9	0.3	9.5	5.0	35.7	0.9	9.5	3.4	19.0
S10	2.2	7.1	4.0	14.3	0.6	7.1	1.6	14.3
S11	2.5	2.4	1.6	9.5	0.3	2.4	0.3	7.1
S12	2.2	4.8	0.9	4.8	0.0	4.8	0.0	2.4
S13	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
S14	0.0	0.0	0.6	0.0	0.6	0.0	0.0	2.4
S15	0.3	2.4	0.0	0.0	0.6	2.4	0.0	2.4
S16	0.3	0.0	13.0	16.7	1.2	0.0	4.0	9.5
S17	0.6	2.4	1.2	4.8	0.3	2.4	0.3	4.8
S18	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0

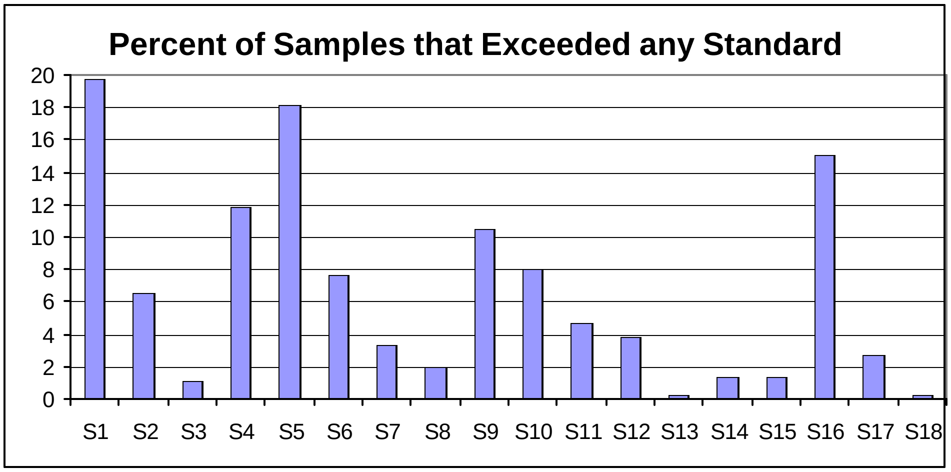


Figure 7. Percent of all Santa Monica Bay shoreline samples that exceeded any of the four bathing standards.

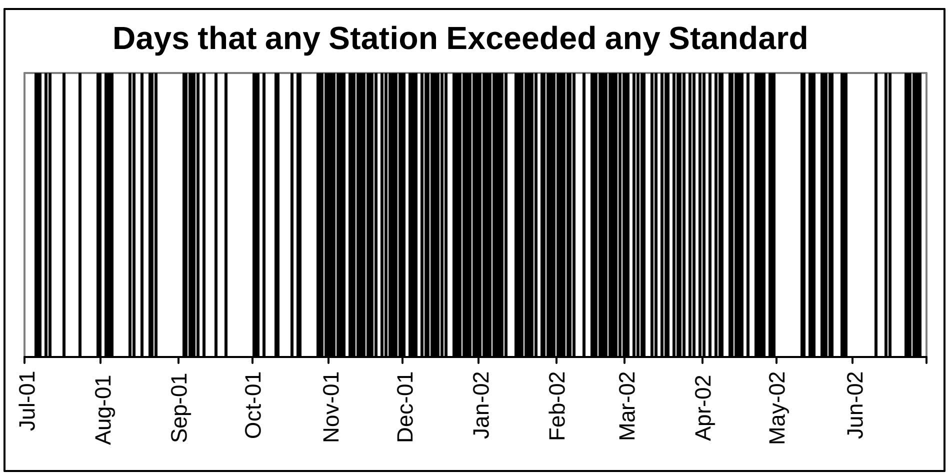


Figure 8. Days on which any Santa Monica Bay shoreline station that exceeded any of the four bathing standards.

IV. DISCUSSION

The influence of urban runoff on the water quality of the Santa Monica Bay is indicated by the increase in bacterial counts as reflected by the annual geometric means for indicator bacteria at shoreline waters when storm drains are flowing during both wet and dry weather (Figures 4 and 5).

A. SHORELINE

The current challenge is to control non-point sources of pollution from urban runoff. EPA estimates indicate that nonpoint sources are the leading cause of impairment to surface water quality nationwide (Perciasepe 1995). Urban runoff, consisting of stormwater and dry weather runoff, is the major nonpoint source of untreated pollution to Santa Monica Bay. The negative impact of this transient and perennial runoff on bacterial water quality limits the recreational use and aesthetic enjoyment of the Bay.

1. Rainfall

The rainy season in Southern California normally occurs during the seven months period from October to April. However, the 2001-2002 did not fit this typical pattern (Figures 2 and 3). The 2001-2002 rainy season began late and ended late (late October through June).

Extensive past monitoring has shown that stormwater runoff significantly impacts the bacteriological water quality of Santa Monica Bay's shoreline (CLA, EMD 1989-2000). Annual geometric means for indicator bacteria (total coliform, fecal coliform, and enterococcus) at all shoreline stations were the highest in 2001-2002 during wet weather due to contaminants in stormwater runoff following rain events (Figures 2, 3, and 4).

Higher wet weather counts during 2001-2002 were the result of more intense rain events and the effects of coliform-bearing contaminants (e.g., animal feces, soil, and plant debris) flowing through the storm drain collection system.

There are several problems associated with attempting to control and treat stormwater runoff. These problems involve the variability of rainfall and the inability to control runoff. Southern California's wettest months are usually January and February, but significant storms may occur from October through April and contribute over 95% of the total annual rainfall. The inherent variability of rainfall can be seen in the amounts and distribution of rainfall for 2001-2002 (Figures 2 and 3).

2. Shoreline Stations

As with stormwater runoff, past monitoring has shown that dry weather runoff significantly impacts the bacteriological water quality of Santa Monica Bay's shoreline (CLA, EMD 1989-2000). The contribution of dry-weather flow to the total volume of runoff into Santa Monica Bay is about 30% (NCR, COWT 1984). This impact on the bacteriological water quality of the Santa Monica Bay shoreline is reflected by the increase in indicator bacterial geometric means during dry weather when storm drains are flowing. In general, the highest geometric means for dry weather during 1999, 2000, and 2001-2002 were at stations associated with flowing storm drains and lagoons in the northern part of Santa Monica Bay (Figure 9 and 10). Only one station in the southern part of the Bay, S16, which is located south of Redondo Beach Pier, had high dry-weather bacterial counts.

Stations S1 and S2 are located near lagoons created and fed by natural creeks, which flow into the ocean when breached. The flow from these lagoons is classified as storm drain runoff. Station S1 (Surfrider Beach) is the outlet of the entire Malibu Creek watershed, which has a drainage area equal to approximately 105 square miles (LACDPW 1996). Highest bacterial densities occur at this station when the lagoon is breached. At station S2 (Topanga Canyon) runoff from the adjacent lagoon is also the major contributor to increased bacterial densities at this station.

Station S3 is located close to the Pulga Canyon storm drain, which is of concern because of its almost continuous flow and occasional high counts, and is only 0.03 miles west of S3. The Santa Monica Canyon storm drain near station S4, has significant flow during dry and wet weather. It drains a large watershed area that contains horse corrals, a golf course, and some houses on septic systems, all of which are potential sources for the increased bacterial densities at this station.

Station S9 is located at Mother's Beach in Marina del Rey. Sources of bacterial contamination at this station are the nonpoint discharges associated with the marina. Also, numerous birds may have been the cause of high indicator bacterial counts at this station in the past. Monofilament lines were installed about ten feet off the ground and have been effective in keeping the birds away from this area.

Station S10 is 0.33 miles south of the Marina del Rey Channel. Even though Imperial Highway and Avenue I storm drains are located near stations S12, and S17, respectively, these stations still had low bacterial densities. Stations S12 through S17 are located in the southern portion of Santa Monica Bay, which has a small watershed and very few industrial dischargers. Station S16, associated with two storm drains and the Redondo Beach Pier, stands out among the stations in the southern part of the Bay because it had the highest bacterial means among the stations in this part of the Bay. The remaining shoreline stations are located near municipal piers or storm drains with little or no detectable flow, and as a result, they have lower bacterial geometric means.

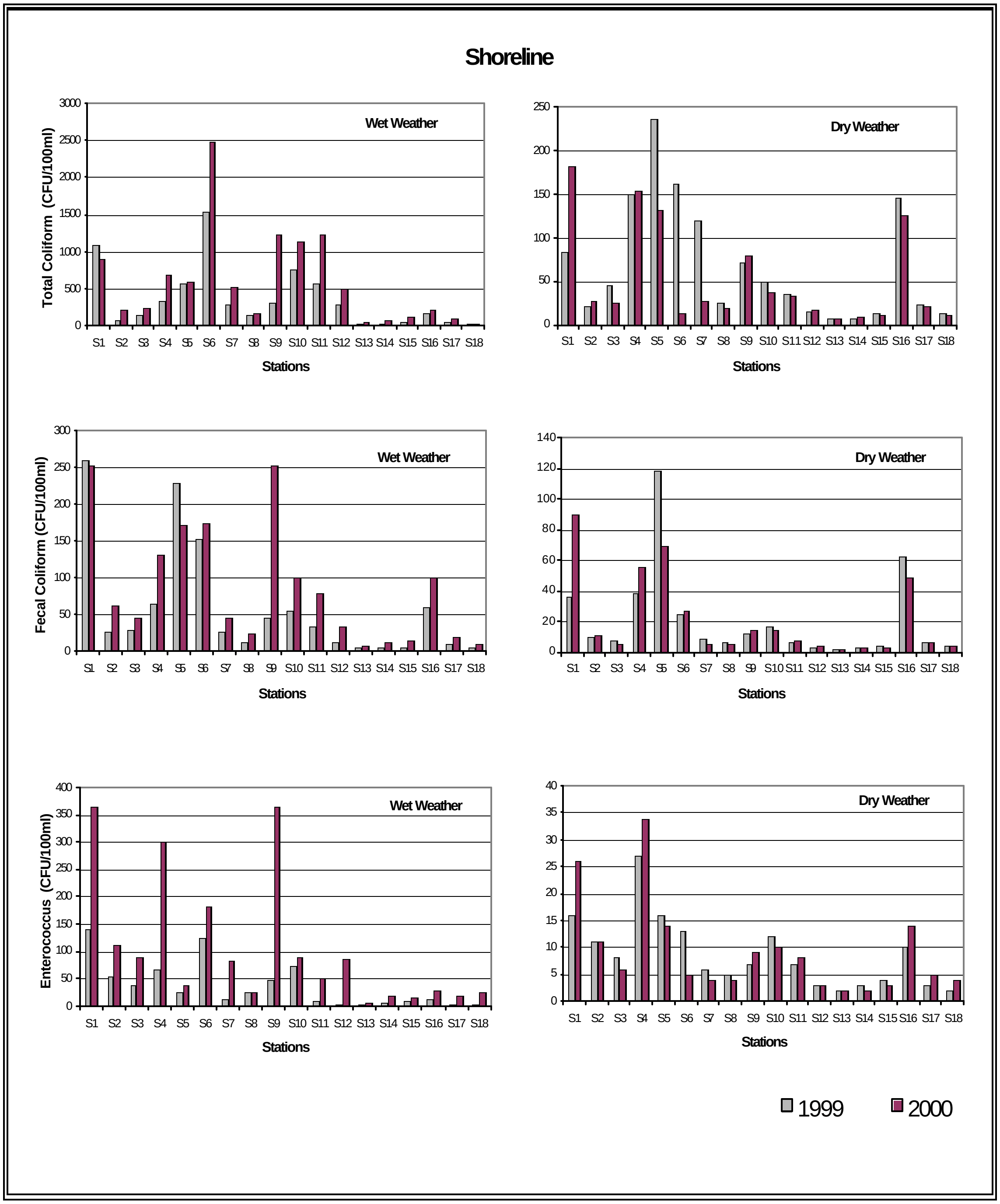


Figure 9. Annual geometric means for indicator bacteria at shoreline stations in Santa Monica Bay, 1999-2000.

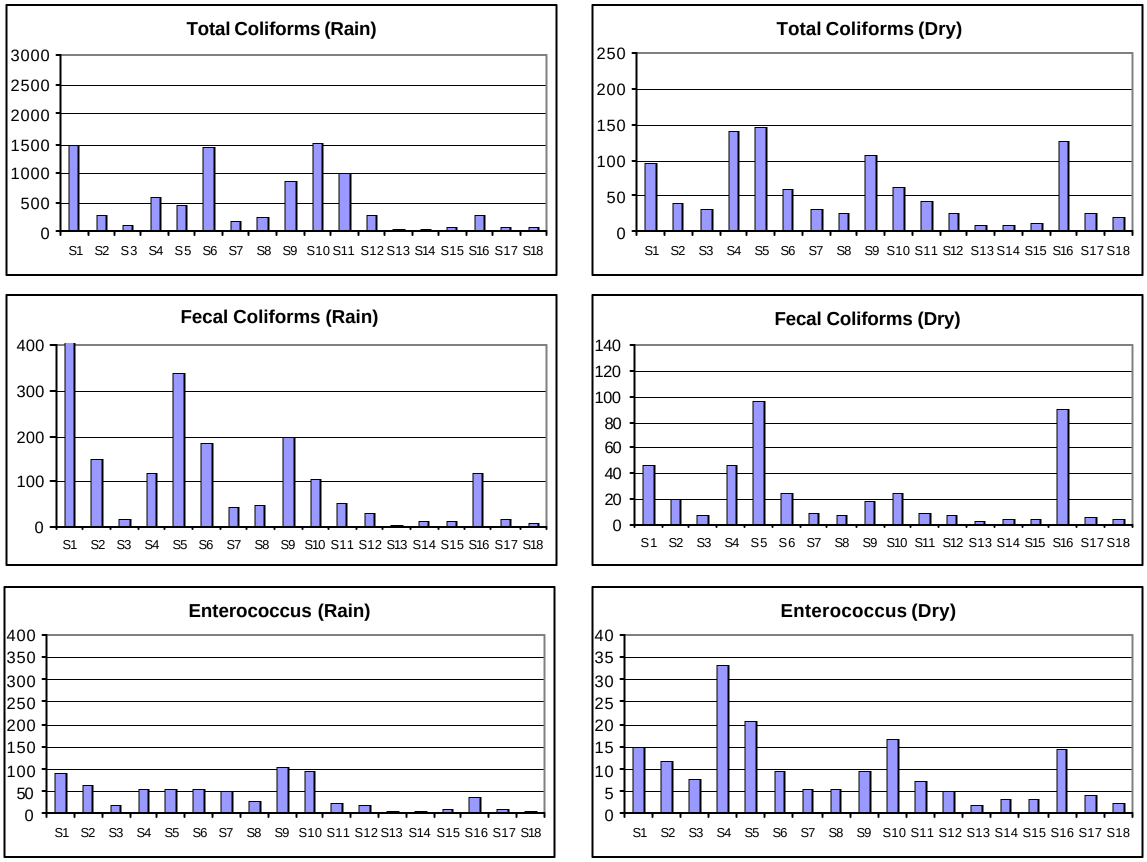


Figure 10. Annual geometric means for indicator bacteria at shoreline stations in Santa Monica Bay, 2001-2002.

5. Water Quality Standards

The health impact of non-point source discharges into Santa Monica Bay is reflected in the number of times that water quality standards were exceeded at the various shoreline-monitoring stations. All shoreline stations exceeded recreational water standards at some time during the 2001-2002 period (Figure 6, Table 3). As programmatic and structural best management practices (BMPs) are implemented to reduce bacterial densities in urban runoff, future shoreline monitoring will be the best tool for evaluating water quality improvements along Santa Monica Bay beaches.

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